Potential of Rainwater Harvesting in Dhaka City: An Empirical Study

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Abstract

The inability of public water facilities to function effectively in Dhaka City has made it impossible for most of the city dwellers to have access to safe water supply. The concept of rainwater harvesting is an economical small-scale technology, which has the potential to boost safe water supply with least disturbance to the environment. Dhaka being a mega city, only limited city dwellers has reasonable access to reliable water supply. This study explores to assess the potential for harvesting of rainwater as an alternative option in Dhaka City, which shows that rainwater can provide significant amount of supply against its demand. There is, therefore, sufficient rainwater to supplement the need of the city dwellers if the arrangement for rainwater harvesting activities could be improved.

Keywords: Rainwater harvesting, water sources, public water supply, household and water storage.

Introduction

The economy and social life of people is intimately linked with its two resources: land and water. Water is its main boon and also the main cause or means of disasters. It is an indispensible substance to man and all life processes, which is widely referred to as universal solvent. It is classified based on sanitary quality as portable, contaminated or polluted. Water can be grouped into atmospheric, surface and ground water. Atmospheric water includes moisture contained in the cloud and which precipitates as snow and rain. Rain water is a form of precipitation in which liquid water falls to the earth's surface. It forms a major part of the hydrologic cycle in which water from the oceans evaporates, condenses into clouds and precipitates back to the earth and eventually return to the ocean via streams and rivers, to repeat the cycle again (Ghisi et al, 2006). Water, a necessary reserve, has been found to be in short supply. About half of the people that live in developing countries do not have access to safe drinking water and 73 percent have no sanitation (WHO and UNICEF, 2006), some of their wastes eventually contaminate their drinking water supply leading to a high level of suffering. Water scarcity causes environmental hazards which have been progressively getting worse in recent years and are likely to become major problems if not tackled urgently. According to the UNDP, over 1 billion people worldwide lack access to water and over 5,000 children dying every day from water-related illnesses. International scientific panels have predicted that water availability may decrease by 10-30 percent over some dry regions of the world by 2050. Demand for water is growing in most cities as every urban citizen requires almost double the amount of water that a rural citizen requires.

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The problem of water scarcity in the surface water system stems from the increasing abstraction of water upstream both within Bangladesh but more particularly upstream of Bangladesh and in India. The inability of public water facilities to function effectively in Dhaka City has made it impossible for most of the city dwellers to have access to safe water supply.

Dhaka City is characterized by rapid population growth and unplanned infrastructural development. As such, water supply to the city dwellers is under enormous pressure to meet the ever increasing demand with quality and equity. Historically, most of Dhaka's water supply comes from its two rivers, the *Buriganga* and the *Shitalakkhya*. But as population has increased and industry has expanded in manifolds since independence in 1971, river water has become contaminated with industrial waste. The average annual rainfall in Dhaka City is more than 2100 mm, which is about three times of the world's average. But, according to a study of Institute of Water Modeling, this city has a critical water supply problem and its groundwater level is falling by three meters per year (Kulkarni, 2011). Groundwater has already receded over fifty meters in the past 42 years, bringing the current level to sixty meters below ground. The supply-demand gap is approximately 500m liters per day. The situation is so problematic that in the summer of last few years, the government deployed troops to manage water distribution in the capital. Today, groundwater is expected to satisfy over 80 percent of the city's water supply. Also infrastructure in Dhaka City is not robust enough to sufficiently recharge groundwater.

Rainwater harvesting (RWH) refers to collection and storage of rainwater and also other activities aimed at harvesting surface and groundwater, prevention of loses through evaporation and seepage and all other hydrological studies and engineering intervention, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit as a watershed (Agarwal and Narain, 1997). Encyclopedia Britannica (2010) refers RWH as the gathering or accumulating and storing of rainwater, which are low-cost systems that collect and store rainwater for year-round use, offers a cost-effective and practical solution to ease water crisis. Broadly there are two ways of harvesting rainwater, i.e. surface runoff harvesting and rooftop rainwater harvesting. It is estimated that RWH systems could supply more than 15 percent of Dhaka's requirements. About 150bn liters of rainwater could be harvested in the whole country during the monsoon season alone and water can be stored for four to five months without bacterial contamination.

RWH has been used to provide drinking water for people and livestock and for irrigation or to fill aquifers in a process called groundwater recharge. Rainwater collected from the roofs of houses, tents and local institutions, or from specially prepared areas of ground, can make an important contribution to drinking water. Rainwater systems are simple to construct from inexpensive local materials and are usually successful in most areas. Roof rainwater can be of good quality and may not require treatment before consumption. However, some rooftop materials may produce rainwater that is harmful to human health. Alam (2006) identifies RWH as an option, which has been adopted in many areas of the world, where conventional water supply systems are not available or have failed to meet the needs and expectations of the people. Rainwater is free from arsenic contamination and the physical, chemical and bacteriological characteristics of harvested rainwater represent a suitable and acceptable means of potable water.

The Study Problem

Currently in Brazil, China and many parts of India (e.g. Tamil Nadu, Pune) rooftop RWH are being practiced for providing drinking water, domestic water, water for livestock, water for small irrigation and a way to replenish ground water levels. In Bermuda, the law requires all new construction to include RWH adequate for the residents. The ownership of water and its impacts of some Asian countries are as follows:

Table 1: Ownership of Water and its Impacts

Country	Status	Description
Sri Lanka	Public Ownership	No restriction on development of domestic rain water harvesting (DRWH).
India	Not Specified	Water is a state object. No potential threat to development of DRWH.
Thailand	State Ownership	Storage of water requires a license as decided by the river basin committee.
Bangladesh	State Ownership	No constraint on development DRWH.

Source: Ariyabandu, 2003

Dhaka Water Supply and Sewerage Authority (DWASA) is the agency mandated for water supply and wastewater management in the whole city. DWASA abstracts groundwater using 600 (March 2012) production wells and 88 percent of its supply comes from groundwater. However, this figure has been discounted considering the fact that more than 2,000 private wells are abstracting groundwater to serve high-rise buildings, institutions and a wide variety of industries located within the city. Due to massive extraction, it is estimated that groundwater level is declining at a rate of 3 m/year in Dhaka City posing a new challenge. On the other hand, water-bodies are disappearing from the city and paved areas are increasing due to massive unplanned urbanization.

Objective of the Study

The broad objective of the study is to assess the potential of the RWH in Dhaka City. However, the specific objectives are as follows:

i. To identify the advantages of RWH;
ii. To explore the challenges associated with RWH; and
iii. To recommend measures to solve the problems in order to introduce the RWH system.

Materials and Method

The method of data collection was through the use of applicable sampling techniques. Three *Thana* areas (Basabo, Mirpur and Muhammadpur) of Dhaka city were selected for this study. Since the research population is made up of the households in the study area, the researchers carried out a stratified sampling to delimit the area of study into three *Thanas* as mentioned earlier. The selected *Thanas* were then delimited using the simple random sampling technique to

select various households for the research work. From each *Thana*, the study samples were taken. Information on the number of households in the various *Thanas* of the study area was obtained from the Ward Commissioners Offices of Dhaka City Corporation (DCC).

The breakdown on how the samples were taken from the households in the three selected *Thanas* is shown in Table 2. Oral interviews was also conducted with some of the household heads together with their spouses and children were engaged in a group discussion on the procedures of RWH, uses of the harvested rainwater and the problems they encounter during periods of water scarcity in their various locations. The people responded to the questions. Few officials of DWASA also interviewed.

Results and Discussion

Table 2 shows the gender, age and education distribution of the respondents. It shows the equal proportion of the respondents, but the mean age is 41 and education levels also vary. No respondents were younger than 22 years, which is not unexpected since mostly household heads were interviewed.

Table 2: Sample Characteristics by Gender, Age and Education

Sample Characteristics		Basabo N=50	Mirpur N=50	Mohammadpur N=50	All N=150
Gender					
	Female	25	25	25	75
	Male	25	25	25	75
Age					
	Minimum	35	22	30	22
	Maximum	44	40	60	60
	Mean	39	31	46	41
Education					
	Primary	10	17	16	43
	Secondary	28	13	15	56
	Tertiary	3	4	4	11
	Informal	9	16	15	40
	Total	50	50	50	150

Table 3 reveals that 10 percent of the sampled households are 2-5 persons. About 76 percent of the households have 6-8 persons in them while 14 percent of the sampled households have more than 9 persons living with them. It also shows the occupation of the respondents. About 7 percent of the respondents indicated that they are government officials. About 5 percent of the respondents are traders. About 85 percent of the respondents are workers/labours; this group represents the largest proportion of the respondents. Artisans, craftsmen and other occupations make up 1 percent each.

Table 3: Number of Persons per Household and Occupation of the Respondents

Household		Respondents' Occupation	
Number of Persons	Percentage	Occupation	Percentage
2-5	10	Government Officials	7
6-8	76	Businessmen	5
9 & Above	14	Workers/Labourers	85
Total	100	Artisans/Craftsmen	2
		Others	1
		Total	100

Figure 1 shows the average daily water usage per household in the study population. The result indicates that 15 percent of the respondents use below 100 litres of water in their households per day. A greater proportion of the respondents (60 percent) make use of about 100-200 litres of water in their respective households per day. About 18 percent of the respondents make use of 201-300 litres of water per day in their households while 4 percent of the respondents use between 301-400 litres of water per day. Those that use about 401-500 litres of water per day in their households were just 2 percent.

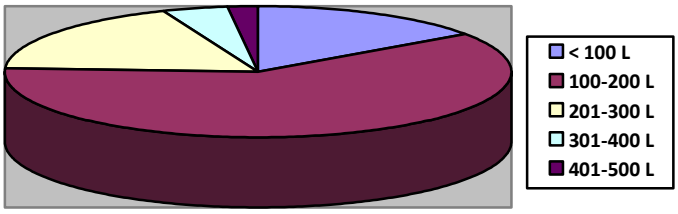

Figure 1: Average Daily Water Used by the Households

Table 4: Rainfall at Different Probability for 3 Different Thana Areas of Dhaka City

Name of the Thana	Probable Rainfall Equation	Correlation Coefficient	Rainfall (mm) at Probability of		
			50%	60%	70%
Basabo	R = -172.73 In(P)+892.57	0.9779	216.8	185.3	158.7
Mirpur	R = -139.88 In(P)+790.98	0.9552	243.7	218.2	196.7
Mohammadpur	R = -152.53 In(P)+878.18	0.9570	320.6	294.6	272.6

Now let us see what happens once we go for the rain water harvesting for approx 2150 sq. ft. each roof top of 1200 plots (Table 5):

Table 5: Rain Water Harvested on the Roof top of 1200 Buildings at DOHS, Mirpur

Month	Rain Fall		At 70% harvest (in Litres)	If 1200 building harvest rain water (in Litres)
	Daily	Monthly		
January	2	62	8,680	1,041,600
February	3	84	11,760	1,411,200
March	5	155	21,700	2,604,000
April	10	300	42,000	5,040,000
May	15	465	65,100	7,812,000
June	14	420	58,800	7,056,000
July	17	527	73,780	8,853,600
August	16	496	69,440	8,332,800
Sep	13	390	54,600	6,552,000
October	7	210	29,400	3,528,000
November	2	60	8,400	1,008,000
December	1	31	4,340	520,800
	Total Collection in a Year (in Litres)			**53,760,000**

Major Findings of the Study

- Major findings of the study show that majority of households in the study area are not aware about harvested rainwater as their major source of water supply while supply of water by DWASA is the main source. Rainwater is popular in many countries of the world but it was never widely used in Bangladesh for drinking or cooking purpose. The study finds, in most cases, people do not know that rainwater is safe for drinking and can be used for a long period. This also simply implies that a large proportion of households in the study area get their water from underground water source.

- Result of the findings also indicated that 15 percent of the respondents use below 100 litres of water in their households per day. A greater proportion of the respondents (60 percent) make use of about 100-200 litres of water in their respective households per day. About 18 percent of the respondents make use of 201-300 litres of water per day in their households while 4 percent of the respondents use between 301-400 litres of water per day and about 2 percent make use of 401-500 litres of water per day in their households. So average daily water usage is inconsistent with the WHO's stipulated 50 litres of clean water a day per individual (World Water Council, 2006), which it considered necessary to stay healthy - for drinking, washing, cooking, sanitation and personal hygiene.

- The results obtained from the study also revealed that major water supply problems faced by the households in the study area include inadequate supply of water by DWASA.

- A few people have the idea that rainwater could be used for drinking and cooking purpose. As a result, the use of purified surface water is preferred as an alternative source.

- It is also evident from the study that though some people recognized rainwater is safe to drink, but their mental preparedness is not adequate to adopt it in their life. However, it is necessary to popularize the use of rainwater as an alternative source of drinking and cooking water.

Recommendations

In order to address the issue of poor RWH system practice in the study area, the following recommendations are made:

- In the present scenario, management and distribution of water has become crucial. As the water crisis continues to become severe, there is a dire need of reform in water management system and revival of traditional systems;
- Revival process should necessarily be backed by people's initiative and active public participation;
- Mass awareness building and training program on the practice and storage procedures of RWH are required;
- Community participation should be encouraged as it can lead to a successful water supply scheme;
- This could be done in the form of personal involvement in the form of contribution of money for the purchase and installation of additional storage facilities;
- The RWH system needs to be incorporated in the academic curricula;
- Proper hygiene should be maintained. Since the harvested rainwater is partially contaminated, so the health branch of DCC should carry out massive awareness campaigns on ways of purifying water before consumption from the available sources.

Conclusion

As the people of Dhaka City are in real trouble for water, so the importance of RWH cannot be overemphasized. When people will know that a scientific and cheap method is within their reach and it is for the betterment of their health, it will positively change their attitude and practice towards multi-uses of rainwater. There is a dire need of reform in water management system and revival of traditional systems. Also community participation should be encouraged as it can lead to a successful water supply scheme.

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